AD-A196 146

DTIC FILE COPY

FINAL REPORT

DTIC ELECTE JUL 0 6 1988 S D CD

Deliverable No.: A006

Prepared by:
JAYCOR

Prepared for:
Naval Research Laboratory
Washington, DC 20375-5000

In Response to:
Contract #N00014-86-C-2044

DISTRIBUTION STATEMENT A

12 May 1988

070

1. INTRODUCTION

JAYCOR is pleased to submit this final report summarizing the tasks performed by JAYCOR at the Navy Center for Applied Research in Artificial Intelligence (NCARAI) and other offices of the Naval Research Laboratory under Contract #N00014-85-C-2044. This report gives a brief overview of the work performed to meet the tasks, location on computers both at the NCARAI and on the main NRL campus where software written to meet the requirements of particular tasks is stored, specific documentation of any aspects of the software which may be unusual or possibly nonintuitive to use, and pertinent information on any problems encountered during the performance of the tasks.

The report is organized on a task by task basis, each task briefly explained and the work summarized. Any software produced, obtained, or otherwise installed to satisfy task requirements is available in source form on NRL computers or archive tapes. In addition to this summary final report, the reader is referred to the numerous monthly reports submitted over the entire period of the contract to more thoroughly document the work performed.

2. TASKS AND WORK PERFORMED

The work of this contract took on a number of different aspects: the development of a powerful interface to underlying data structures, implementation of an evolving probabilistic Expert System, examination of the needs behind a Natural Language knowledge base, devising, presenting, and implementing an "intelligent" communications network management system, and the investigation of the feasibility of applying some of these concepts to multiple sensor information integration.

The subsections below briefly summarize the approach taken to each task and provide pointers to further information and the location of implemented software, as well as observations on the direction that research into the varied topics has taken.

2.1. AN IMPROVED INFERENCE ENGINE

An set of modules were implemented on the LMI Lisp machine to allow dynamic creation, modification, and deletion of Flavors and Flavor instances. This Object-oriented mechanism greatly enhances and facilitates the inferencing mechanism due to the hierarchical nature of the structures used by it. The fairly complex set of routines allows the user to interactively and dynamically create "objects" that are in a hierarchy not only of **data** structures, but also, due to its basis in the Flavors paradigm, in a hierarchy of **procedure** structures. Unlike the Flavors method of object creation, however, this hierarchy permits the **redefinition** of entities "on the fly", with reinstantiation performed automatically as needed. Thus for example, one can define an entity, such as a ship, use the results, then come up with an enhanced definition. Rather than needing to create a new type of object to handle this enhanced definition or needing to add to an old definition (with possibly redundant or incorrect information retained) as is the practice under the Flavors paradigm, one can actually **modify** the existing Object definition, with the changes automatically propagated throughout all definitions. The

reader is referred to the report previously submitted titled "The Objects Manual" for more thorough explanation of the structure and use of the routines.

2.2. EXPERT SYSTEM

The work performed to meet the requirements of this task is a continuing effort, evolving toward a general purpose reasoning tool which will be of great assistance to the NCARAI's ship classification project. Ported to the Symbolics LISP machines, the system has been generalized to handle multiple domains (for example, economic reasoning, ship classification, etc.) through the use of probabilistic causal networks. Dr. Lashon Booker of NRL and Mr. Naveen Hota of JAYCOR coauthored a paper titled "Probabilistic Reasoning About Ship Images" which described the knowledge-based system that has been implemented with an enhanced inferencing mechanism developed by Pearl and Kim ("A Computational Model for Combined Causal and Diagnostic Reasoning in Inference Systems, Proceedings of IJCAI-83). This paper was presented at the AAAI Workshop on "Uncertainty in Artificial Intelligence" held at the University of Pennsylvania in August 1986. The reader is referred to this paper to much more thoroughly explain the implementation of the new inference engine, reasons for changes, and a comparison with the old.

2.3. KNOWLEDGE ACQUISITION

For this task the feasibility of applying the results of the previous two tasks to the implementation of an inference mechanism for the integration of multiple diverse sources of information was to be investigated in addition to the consideration of the manipulation and control of the knowledge base.

A report titled "Knowledge Acquisition and Refinement" was written on the many aspects of the problem. This report discusses methods currently used to both acquire and refine (or make more exact) information, examines some of the issues involved in designing a new generalized Knowledge Acquisition tool, and examines some of the problems involved when trying to handle explanation and correction of the knowledge base. The reader is referred to this report to more thoroughly document some of the work performed for this task.

DTIC
COPY
INSPECTED
6

2.4. INTERFACE IMPLEMENTATION

A user interface to underlying data structures was written to meet the requirements of this task. This interface allows simple yet powerful matching of hierarchically arranged patterns to be matched, either completely or partially against the existing knowledge base structures. A report was written describing this package titled "The PATTERNS Manual". The reader is referred to this report to more thoroughly document some of the work performed to meet the requirements of this task.

In a related effort, the causal network expert system developed under this contract had a highly graphical user interface, using the power of the LISP machine's visually oriented display and mouse for ease of selection.

2.5. NETWORK MANAGER ANALYSIS

The requirements for a communications network management facility are varied and many. Statistical and analytical methods were used to accumulate information on network trends, faults, and other important events (noting that a **simulated** network was being used). This information was used to aid in the setting of parameters for the Network Management System. A prototype system was written and installed on the Sun Workstation known as "nrl-onyx.arpa" on the main NRL campus.

Mr. William Thoet of JAYCOR investigated this task deeply, producing as results not only the prototype system mentioned above, but also a number of presentations and papers. The presentations were mostly demonstrations of the Monitoring/System for NRL, SPAWAR, and NOSC. In addition, a formal presentation of the "Constrained Flooding Algorithm" and a formal presentation of the "SDI Communication System Simulation" were given to NRL and other researchers. Finally, In order to familiarize others with the intricacies of his work, Mr. Thoet also gave short lectures on the Simula programming environment to other researchers on the project.

In addition to the formal and informal presentations, Mr. Thoet authored and presented the paper "A Reliable Constrained Flooding Algorithm for SDI" for MILCOM 86 in Monterey, California. He also co-authored a paper with NRL employees D. Baker and J. Hauser for the IEEE Journal on Selected Areas in Communication titled "A Distributed Simulation and Prototyping Testbed for Radio Communication Networks", due to be published in January 1988.

2.6. NETWORK MANAGER

As mentioned above, a prototype Network Manager was developed and installed on the Sun Workstation known as "nrl-onyx.arpa" on the main NRL Campus. The system takes full advantage of the graphics capabilities of the Sun, allowing the user to display multiple views of the communications network. For example, the user can select a "God's Eye" view, looking down on the world and viewing the network as interconnecting lines between communications nodes (with multiple projection capabilities), or an alternate view such as from the ground looking up at the "currently visible" communications nodes (a simulation of the "within range window" of communication satellites).

Due to its user-friendly design the system is easy to use; all commands are invoked through menu selection. In addition, it is quite easy to learn, with most actions being intuitive in nature.

2.7. NETWORK SIMULATION

Since no real communications network exists to test the validity of some of the aspects of the software mentioned above, a simulation of a network was required. Due to the ease of implementation facilitated by the University of Calgary's JADE system, this in coordination with the JIPC interprocess protocol and the Simula programming language were used to create a simulation of a complex network. The "outputs" of

this dynamic simulation are used by the analysis and management software for testing purposes.

All software written for this task is stored on the Sun Workstation computer known as "nrl-onyx.arpa" on the main NRL Campus.

2.8. KNOWLEDGE REPRESENTATION REPORT

An examination on knowledge representation languages and tools was made and a report titled "Narrative Domain Representation" was written and submitted to meet the requirements of this task. The report discusses the various aspects to the problem of knowledge representation and presents brief summaries of currently existing methodologies. Finally it examines the University of Maryland YAPS system and explains why the selection of this system for implementation of a CASREP knowledge domain was made. The reader is referred to the report noted above for more thorough information.

3. CONCLUDING REMARKS

The use of multiple sources of information can be an extremely powerful aid to the solution of problems. The results of the work on the tasks of this contract show that a variety of sources of information are intimately related in many ways. These sources can be combined to form a much better overall "picture" of the current situation.

As with any research related efforts, the work performed to meet the requirements of the tasks of this contract continues at this writing even thought he tasks themselves have been met. Systems developed then are still evolving into something "better" as ideas are conceived and discarded. JAYCOR believes this new work will build upon the old in a manner beneficial both to the Navy and the Naval Research Laboratory's mission. We look forward to continuing our relationship to the Navy's AI Center in the future.